Draft Final FYR

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GENERAL MILLS/HENKEL CORP SUPERFUND SITE
MINNEAPOLIS, MINNESOTA

FIVE-YEAR REVIEW REPORT

September 2014

DRAFT-FINAL

Prepared by

Minnesota Pollution Control Agency
St. Paul, Minnesota

Sandeep Burman, Section Manager **Date**

Table of Contents

DRAFT-FINAL

List of Tables

List of Appendices

DRAFT-FINAL

ACRONYMS AND ABBREVIATIONS

µg/L ..... micrograms per liter
µg/m^3 ..... micrograms per cubic meter
ADAF ..... age-dependent adjustment factor
AMR ..... Annual Monitoring Report
ARAR ..... applicable or relevant and appropriate requirement
Bay West ..... Bay West LLC
bgs ..... below ground surface
CERCLA ..... Comprehensive Environmental Response, Compensation, and Liability Act
CFR ..... Code of Federal Regulations
cm/sec ..... centimeters per second
Consent Order .. Response Order by Consent
DMR ..... discharge monitoring report
DNR ..... Minnesota Department of Natural Resources
FS ..... Feasibility Study
ft ..... feet or foot
ft/ft ..... feet per foot
FYR ..... Five-Year Review
GIS ..... geographic information system
GMI ..... General Mills Incorporated
HBV ..... Health Based Value
HRL ..... Health Risk Limit
IC ..... institutional control
IRIS ..... Integrated Risk Information System
ISV ..... intrusion screening level
kg ..... kilogram
L ..... liter
lb/yr ..... pounds per year
LTM ..... long-term monitoring
m ..... meter
m^3 ..... cubic meter
MCL ..... Maximum Contaminant Level
MCLG ..... Maximum Contaminant Level Goal
MDH ..... Minnesota Department of Health
mg ..... milligram
mg/kg ..... milligrams per kilogram
MPCA ..... Minnesota Pollution Control Agency
msl ..... mean sea level
NCP ..... National Oil and Hazardous Substances Pollution Contingency Plan
NPDES ..... National Pollutant Discharge Elimination System
NPL ..... National Priorities List
O&M ..... operations and maintenance
RA ..... remedial action
RAO ..... remedial action objectives
RAP ..... Remedial Action Plan
RfC ..... reference concentration
RI ..... Remedial Investigation
SECIA ..... Southeast Como Improvement Association
Site ..... General Mills/Henkel Corporation Site
SWCA ..... Special Well and Boring Construction Area
TCAAP ..... Twin Cities Army Ammunition Plant
TCE ..... trichloroethylene
UECA ..... Uniform Environmental Covenants Act
USEPA ..... U.S. Environmental Protection Agency
UU/UE ..... unrestricted use/unlimited exposure
VOC ..... volatile organic compounds
yr ..... year

DRAFT-FINAL

EXECUTIVE SUMMARY

The Minnesota Pollution Control Agency (MPCA) has completed this Five-Year Review (FYR) of the remedial action (RA) implemented at the General Mills/Henkel Corporation (Site) located at 2010 East Hennepin Avenue, Minneapolis, Minnesota. This is the Fifth FYR Report for the Site, which evaluates the effectiveness of the RA to date.

In 1981, General Mills Incorporated (GMI) initiated an investigation into a former soil absorption pit located on the southern portion of the Site. The soil absorption pit was constructed of three stacked and perforated 55-gallon drums buried to an approximate depth of 12 ft. From approximately 1947 to 1962 the soil absorption pit was utilized to dispose of approximately 1,000 gallons of laboratory solvents per year.

In 1984, GMI and the MPCA finalized a Response Order by Consent (Consent Order) which established the RAs for groundwater at the Site. The selected remedy addressing groundwater as a drinking water resource at the Site is groundwater pump-out and treatment along with containment by means of groundwater extraction. The groundwater pump-out and treatment systems were placed into operation in late 1985.

After twenty-five years of pump-out and treatment system operation, the groundwater cleanup concentrations specified in the Consent Order were achieved. Therefore, in accordance with and MPCA-approved RA plan, the pump-out and treatment systems were shut down on September, 13, 2010. However, the groundwater pump-out wells and the monitoring well network remain in place in the event system startup is warranted. In addition, long-term monitoring and operation and maintenance are ongoing.

In summary, the groundwater remedy is functioning as intended by the Consent Order and the drinking water pathway remains protective of human health and the environment. Groundwater monitoring indicates that the idled pump-out and treatment systems continue to meet the RAOs and cleanup levels as specified in the Consent Order. However, an increase in TCE concentrations in recent sampling events indicates an increase in contaminant concentrations may be occurring.

Several monitoring and pump-out wells appear to require more frequent maintenance. These wells are only inspected during the groundwater monitoring events (currently every five years). Consequently, annual well inspection and repair, as necessary, is recommended.

Recent concerns have been raised about the TCE concentrations in the shallow groundwater and the potential vapor intrusion pathway posed to buildings in vicinity of the Site. In accordance with RAP Modification #1 to the Consent Order, investigation activities are underway to assess the TCE vapor intrusion pathway to buildings in a vapor study area established based on the known TCE impacted areas, and sub-slab vapor mitigation systems are being installed in residential buildings to address the vapor intrusion pathway. Evaluation of the vapor intrusion pathway RA plan implementation will be assessed in more detail in subsequent FYRs.

Additional detail on the FYR is provided in the FYR Summary Form on the following pages, including issues identified recommendations to address those issues, and protectiveness statements.

DRAFT FINAL

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: General Mills/Henkel Corporationoration		
EPA ID: MND051441731		
Region: 5	**State:** MN	**City/County:** City of Minneapolis/Hennepin County

SITE STATUS	
NPL Status: Final	
Multiple OUs? No	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: State **If "Other Federal Agency" was selected above, enter Agency name:**
Author name (Federal or State Project Manager): Edward Olson
Author affiliation: Minnesota Pollution Control Agency .
Review period: 4/4/2014 to 9/21/2014
Date of site inspection: May 1, 2014
Type of review: Policy
Review number: 5
Triggering action date: Proposed end date of the Fourth FYR. However, the Fourth FYR was only completed in draft form and never signed.
Due date *(five years after triggering action date)*: Proposed end date of the draft Fourth FYR: 9/21/2009.

DRAFT FINAL

Issues/Recommendations				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): Groundwater	**Issue Category:** Operation and Maintenance			
	Issue 1: The site inspection identified several wells requiring maintenance and repair.			
	Recommendation: Repair Wells			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
Yes	Yes	GMI	MPCA	11/1/2014
OU(s): Groundwater and Soil	**Issue Category:** Institutional Controls			
	Issue 2: The legal description alone is not adequate to identify the "Groundwater Impacted Area" and the "Soil Impacted Area".			
	Recommendation: Create a figure with GIS coordinates. Place figure in a readily available location for potential future needs (i.e., utility locators and construction).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	GMI	MPCA	2/15/2015
OU(s): Groundwater	**Issue Category:** Operation and Maintenance			
	Issue 3: Most of the wells are in high traffic areas and LTM & O&M of the wells every five years is not adequate to ensure compliance with the Minnesota well code.			
	Recommendation: Annual LTM and O&M are recommended.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
Yes	No	GMI	MPCA	2/15/2015
OU(s): Groundwater	**Issue Category:** Monitoring			
	Issue 4: LTM of groundwater every five years is not adequate to monitor compliance with RAOs and cleanup levels.			
	Recommendation: Annual LTM is recommended.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**

DRAFT FINAL

No	Yes	GMI	MPCA	2/15/2015
OU(s): Groundwater and Air	**Issue Category:** Changed Site Conditions			
	Issue 5: Groundwater to indoor air pathway. Cleanup levels for vapor intrusion have not been established.			
	Recommendation: Develop groundwater RAOs and cleanup levels for vapor intrusion pathway.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
Yes	Yes	GMI	MPCA	2/15/2015
OU(s): Groundwater	**Issue Category:** Monitoring			
	Issue 6: Groundwater monitoring network is inadequate.			
	Recommendation: Monitoring wells will be installed as part of vapor intrusion investigation.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	GMI	MPCA	2/15/2015
OU(s): Groundwater, Sol, and Air	**Issue Category:** Changed Site Conditions			
	Issue 7: Toxicity values for TCE have decreased.			
	Recommendation: Complete comprehensive risk assessment for all pathways.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	GMI	MPCA	6/15/2015

DRAFT-FINAL

Protectiveness Statement(s)		
Operable Unit: Groundwater (Drinking water Pathway)	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* Not Applicable
Protectiveness Statement: The groundwater remedy is protective of human health and the environment.		

Protectiveness Statement(s)		
Operable Unit: Soil (Direct Exposure pathway)	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* Not Applicable
Protectiveness Statement: No soil cleanup levels were specified in the Consent Order. No further action remedy for the soils is protective of human health and the environment.		

Protectiveness Statement(s)		
Operable Unit: Air (Groundwater to Vapor Intrusion pathway)	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):* Next FYR
Protectiveness Statement: A new exposure pathway (vapor intrusion) has been identified. The sub-slab soil vapor mitigation systems currently protect human health and the environment because sub-slab vapors are being intercepted prior to entering indoor air. However, in order for the remedy to be protective in the long-term, an RI and FS, including a risk evaluation, must be completed, and RAs implemented as needed to ensure protectiveness. This exposure pathway will be evaluated at the next FYR.		

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I. INTRODUCTION

This Fifth Five-Year Review (FYR) Report has been developed for the General Mills/Henkel Corporation Site (Site), located in Minneapolis, Minnesota.

I.1 The Purpose of the Review

The purpose of an FYR is to determine whether the remedy originally selected and implemented at a site continues to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports. In addition, FYR reports document issues found during the review, if any, and make recommendations on how to best to address the issues.

I.2 Authority for Conducting the Five-Year Review

The Minnesota Pollution Control Agency (MPCA) prepared this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The MPCA interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) §300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

I.3 Who Conducted the Five-Year Review

The MPCA, in consultation with the United States Environmental Protection Agency (USEPA) Region 5, has conducted this Fifth FYR of the remedial actions implemented at the Site. This review was conducted from April 2014 through September 2014. This report documents the results of the review conducted with the assistance of MPCA contractor, Bay West LLC (Bay West) of St. Paul, Minnesota. The MPCA is the lead environmental regulatory agency for the implementation and oversight of response actions at the Site. USEPA has not signed the Site decision documents.

I.4 Other Review Characteristics

This is the fifth FYR for the Site. The triggering action for this policy review is the ending date of the draft Fourth FYR Report. However, the draft was never finalized. The last official signed FYR was the Third FYR Report as shown on USEPA WasteLAN database: September 21, 2004. Therefore, for the record, this Fifth FYR Report will also summarize the draft Fourth FYR Report, including:

DRAFT FINAL

- Actions taken since the Third FYR.
- Recommendations and follow-up actions outlined in the draft Fourth FYR and actions taken since that review.

This FYR was conducted by the MPCA following USEPA policy to review sites where remedial actions require longer than five years to achieve performance goals established for the Site.

DRAFT-FINAL

II. SITE CHRONOLOGY

Table 1: Chronology of Site Events

Event	Date
Initial discovery of problem or contamination; investigation performed by GMI; drums and piping associated with the soil absorption pit were reportedly excavated.	1981
Pre-National Priorities List (NPL) response: General Mills installed 27 monitoring wells.	1982-1984
Remedial Investigation/Feasibility (RI/FS) Study complete: GMI completed "Summary of Remedial Actions"	1983
NPL listing	September 21, 1984
Response Order by Consent (Consent Order) for the Site is finalized establishing the Remedial Action (RA) for the Site as "Groundwater Pump-out Systems"	October 23, 1984
Six groundwater containment wells were installed	1985
Containment wells began operation/begin pump-out & treatment/construction completion date	November/December 1985
Two additional containment wells were installed Additional RA construction completion date/	August 1992
First FYR Report	September 1994
Second FYR Report	September 23, 1999
GMI completed additional soil assessment at the soil absorption pit	May 2001
Third FYR Report	September 2004
Site Soil and Groundwater Restrictive Covenant signed by MPCA and GMI on September 23, 2004, and recorded in Hennepin County on November 11, 2004	November 11, 2004
Draft Fourth FYR Report (not-finalized or signed)	September 21, 2009
Continued operation, maintenance, and monitoring of the pump-out and treatment systems.	1985 through September 13, 2010
Groundwater pump-out and treatment systems discontinued	September 13, 2010
Continued groundwater monitoring and maintenance of pump-out and treatment systems.	September 13, 2010 through present
Vapor intrusion investigation and mitigation activities	2012 through present
GMI conducted soil gas survey	April 2012
MPCA and Minnesota Department of Health (MDH) issued notification to tenants, residents, and property owners of vapor intrusion risks	November 6, 2013
Remedial Action Plan (RAP) Modification #1 to the Consent Order for vapor intrusion	March 11, 2014
GMI completed additional soil assessment at the soil absorption pit	May 23, 2014

DRAFT-FINAL

III. BACKGROUND

III.1 Physical Characteristics

The Site is located at 2010 East Hennepin Avenue in Minneapolis, Minnesota (**Appendix A, Figure 1**). The Site is approximately 7 acres in size and was originally owned by GMI and utilized as a food and chemical research facility from 1930 through 1977. The property was purchased by the Henkel Corporation in 1977 and later by BDD Holding in 1989 and First & First LLC in 2012.

III.2 Land and Resource Use

The Site has historically been used for industrial purposes. Nearly the entire Site is covered either by paved surface or buildings. The Site is currently occupied by various businesses. The majority of the Site is zoned as industrial, yet a portion is zoned as residential.

The land use to the north of the Site is primarily industrial. The land use directly east and south of the Site is residential, while the west side is bordered by railroad and beyond that by additional residential property. Approximately 5,000 people live within 1 mile of the Site.

Currently the Site and all of the properties in the area are connected to the Minneapolis municipal water supply. Water for the municipal system is obtained from the Mississippi River north of the city, upstream of the Site.

III.3 History of Contamination

The Site was primarily utilized as a technical research facility from 1930 until 1977. GMI primarily conducted food research at the Site from 1930 to 1947. In 1947, GMI began chemical research at the Site. From 1947 through 1962, a soil absorption pit was utilized to dispose of laboratory solvents. The absorption pit located in the southeastern area of the Site was constructed of three, perforated, 55-gallon drums, stacked and buried to a depth of approximately 12 feet (ft) below ground surface (bgs). Approximately 1,000 gallons of laboratory solvent were reportedly disposed of in the absorption pit each year during its operation.

GMI notified the MPCA of the soil absorption pit location and the approximate disposal volumes at the Site on or about June 12, 1981. Since 1981, GMI has continued operation, maintenance, and investigation with regards to soil and groundwater contamination at and downgradient of the Site.

III.4 Initial Response

In 1981, GMI conducted a subsurface investigation at the former soil absorption pit. The 1981 investigation and a subsequent investigation in 1983 identified volatile organic compound (VOC)-impacted soil and groundwater in the area of the former absorption pit. The absorption pit drums and associated piping were reportedly removed, yet removal action documentation is not in the Site documentation.

From 1982 through 1984, 27 monitoring wells were installed at and near the Site. Laboratory analysis of groundwater samples collected indicated that VOCs were present in the glacial drift aquifer, the Platteville Formation, St. Peter Sandstone, and the Prairie du Chien Group. The predominant VOC detected was trichloroethene (trichloroethylene; TCE).

III.5 Basis for Taking Action

The initial investigations identified VOC contaminants in the soil and groundwater at the Site in the area of the former absorption pit, including TCE, benzene, toluene, xylene, methyl isobutyl

DRAFT-FINAL

ketone, ethylbenzene, methylene chloride, 1,1,1-trichloroethane, 1,1,2,2-tetrachlorothane, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethene, and chlorobenzene. As noted in the 1984 Consent Order, "(3) "hazardous substances" as defined by Minnesota Statute § 115B.02 have been detected at the Site; (4) the migration and threatened migration of these hazardous substances into the ground water beneath the Site constitutes a "release or threat of release" as that term is defined in Minn. Stat. § 115B.02, subd. 15." (MPCA, 1984)

DRAFT-FINAL

IV. REMEDIAL ACTIONS

As noted previously, initial remedial actions included the removal of drums and piping associated with the absorption pit. Based on the findings of the initial soil and groundwater assessment, GMI analyzed different remedial alternatives in 1983 to address the Site contamination. The alternatives were presented in a document "Summary of Alternative Remedial Actions" (Barr, 1983) and are listed below:

1. No Action.
2. Excavation of contaminated soils in the vadose zone.
3. A 45-ft-diameter excavation of contaminated soils to a depth of 30 ft (vadose and saturated zone).
4. A 70-ft-diameter excavation of contaminated soils to a depth of 30 ft.
5. Venting of the vadose zone in conjunction with a groundwater pump-out system.
6. Groundwater pump-out system.
7. Slurry wall and cap.
8. Soil washing in conjunction with a groundwater pump-out system.

IV.1 Remedy Selection

The groundwater pump-out and treatment systems remedy was chosen since the other listed options would not eliminate the need for, or significantly reduce the operating time for, the groundwater pump-out and treatment systems. The decision to use a groundwater pump-out and treatment systems was finalized on October 23, 1984, through a Consent Order between GMI and the MPCA. The Consent Order only addressed VOC contaminants found within groundwater at and downgradient of the Site.

The Consent Order indicated that initial investigations concluded that there are minimal VOC impacts present in the unsaturated soil above the drift aquifer. Further investigation conducted in 2001 confirmed this assessment (Barr, 2001). GMI received a letter from the MPCA dated September 28, 2001, indicating that “no further action is needed to remediate soils at this point in time.” (MPCA, 2001)

The RAP, included as Exhibit A to the October 23, 1984, Consent Order (MPCA, 1984), identifies the selected remedy to address VOC contaminants in groundwater at and downgradient of the Site. The RAP states the remedial action objectives (RAOs) of the selected remedy as:

> *“The purpose of Part I of this Remedial Action Plan... is to define and implement the procedures necessary for minimizing the further migration of volatile organic hydrocarbons and in particular trichloroethylene (TCE) detected near the General Mills absorption pit in the ground water in the glacial drift and the Platteville Formation, and to improve the quality of the groundwater in the glacial drift and Platteville Formation in the area of the General Mills absorption pit.”*

The RAP established that the glacial drift groundwater extraction wells were to be completed within areas where identified TCE concentrations exceeded 270 micrograms per liter (µg/L). Additionally, requirements for Carimona Member extraction wells were to be completed in areas where identified TCE concentrations exceeded 27 µg/L. Magnolia member RAs were to be evaluated if performance of the Carimona Member pump-out wells did not affect the Magnolia Member groundwater.

DRAFT FINAL

The RAP further states additional RAOs as:

> *"The purpose of the groundwater monitoring program is to: (1) monitor the effectiveness of the groundwater pump-out systems; (2) define changes in the distribution of volatile organic hydrocarbon concentrations listed in Attachment C to this RAP after this RAP is implemented; and (3) determine when operation of the Pump-out system can be modified or terminated."*

IV.1.1. March 2014 Consent Order Modification

In April 2012 GMI conducted a soil gas survey in the vicinity of the Site and surrounding VOC plume which confirmed the presence of TCE in the soil gas above risk criteria established by the MPCA. The VOC groundwater contaminant plume was identified as the likely source of TCE present in the soil gas samples and the soil gas vapors pose risks of vapor intrusion into buildings in the vicinity of the Site. As a result, under the regulatory oversight of the MPCA, GMI took immediate investigative and interim response action in the area near the Site to ensure the protection of human health, welfare, and the environment (MPCA, 2014)

In order to address potential vapor intrusion risks associated with the VOCs the Consent Order was amended on March 11, 2014, "RAP Modification #1" (MPCA, 2014) to:

> *"affirm the investigative and interim actions that have been performed to date and to further address the potential vapor intrusion risks associated with VOC contamination from the Site; to conduct additional sampling and monitoring of soil, soil gas, and groundwater to collect data necessary to identify and evaluate response action alternatives as may be necessary to mitigate the vapor intrusion pathway and reduce VOC concentrations in soil, soil gas, and groundwater."*

The MPCA and GMI agree as follows:

> *"The purpose of the RAP Modification #1 is to implement the response actions set forth herein as necessary to address potential vapor intrusion risks associated with the volatile organic compounds listed on Attachment F due to General Mills' operation of its former facility at 2010 East Hennepin Ave. (the Site). The primary constituent of concern is trichloroethylene (TCE). The response actions to be performed by General Mills pursuant to this RAP Modification #1 shall include: 1) sub-slab sampling and mitigation of potential vapor intrusion from VOCs in the soil and groundwater due to General Mills' operations at the Site; and 2) to conduct additional sampling and monitoring of soil, soil gas, and groundwater to collect data necessary to identify and evaluate response action alternatives as may be necessary to reduce VOC concentrations in soil, soil gas and groundwater due to General Mills' operations at the Site to concentrations that adequately protect human health and the environment. "*

GMI is currently performing investigation and soil gas mitigation activities at and in the vicinity of the Site. These actions will be evaluated under the next FYR.

IV.1.2. Other Remedial Actions

Several types of institutional controls (ICs) have been implemented for protection of public health and the environment limiting access to impacted soil and/or groundwater at the Site. These ICs are described in **Section IV.2.3**.

IV.2 Remedy Implementation

Pump-out and treatment systems were implemented in accordance with the 1984 Consent Order to reduce downgradient migration of VOC contaminants. The current system consists of seven pump-out wells, a water treatment facility, and monitoring well networks in the following

DRAFT - FINAL

geologic units: the glacial drift, the Magnolia member of the Platteville Limestone, the St. Peter Sandstone, and the Prairie du Chien/Jordan aquifer. Existing groundwater extraction wells and monitoring wells are shown in **Appendix A, Figure 1**.

Generalized geologic cross sections of the Site are included in historical data located in **Appendix B** (Barr, 2013a and Barr, 2014a). As shown in the cross-sections, there are about 50 ft of unconsolidated sediment underlying the Site. As much as 10 ft of fill and peat are present near the ground surface.

Underlying the fill and peat is about 30 to 50 ft of sand alluvium, and 0 to 10 ft of clay till at the base. The uppermost bedrock is either the Decorah Shale (0- to 5-ft-thick) or the Carimona member of the Decorah Shale confining unit (note that the Carimona member was re-assigned during this review period from the Platteville Formation and is now the lower member of the Decorah Shale confining unit) (Barr, 2013a).

Groundwater generally flows southwest toward the Mississippi River. The water table occurs at about 830 to 840 ft above mean sea level (msl) beneath the Site, and the river is at about 725 ft above msl. There are downward gradients from the glacial deposits to the St. Peter Sandstone, and because of this, the groundwater in the Carimona Member beneath the Site flows toward the northwest. Flow in the underlying Magnolia Member is toward the Magnolia pump-out wells (**Appendix B**; Barr, 2013a).

A data review of the treatment system, including groundwater pump-out and monitoring wells is included in **Section VI.4**. As noted in **Section II** Site Chronology, the groundwater pump-out and treatment systems were discontinued on September 13, 2010. However, the system remains in place in the event system startup is warranted.

IV.3 Institutional Controls

Institutional controls are not addressed in the Consent Order; however, ICs are in place at the Site following recommendations from the previous FYRs. Institutional controls are non-engineered instruments, such as administrative and/or legal controls that minimize the potential for exposure to contamination and protect the integrity of the remedy. Compliance with ICs is required to assure long-term protectiveness for any areas of the Site where unlimited use or unrestricted exposure (UU/UE) is not allowed. **Table 2** summarizes the Institutional Controls in place at this Site. These controls are further described in the subsequent paragraphs.

Table 2 Institutional Controls Summary Table

Media, Engineered Controls, & Areas that Do Not Support UU/UE Based on Current Conditions	IC Objective	Title of IC Instrument Implemented (note if planned)
Soil greater than 4 ft bgs	Soil Impacted Area shall be used for industrial/commercial purposes only; No disturbance or alteration that would expose or disturb the subsurface soils (>4 ft bgs)	Declaration of Restrictions and Covenants and Affidavit Concerning Real Property Contaminated with Hazardous Substances Document # 8471566 as recorded by the Hennepin County Recorder Office.

DRAFT-FINAL

Table 2 Institutional Controls Summary Table

Media, Engineered Controls, & Areas that Do Not Support UU/UE Based on Current Conditions	IC Objective	Title of IC Instrument Implemented (note if planned)
Groundwater	No disturbance or dewatering of groundwater is to take place beneath the Groundwater Impacted Area without prior authorization from the MPCA.	Declaration of Restrictions and Covenants and Affidavit Concerning Real Property Contaminated With Hazardous Substances Document # 8471566 as recorded by the Hennepin County Recorder Office.
Groundwater.	Requires notification of proposed construction of a groundwater supply well to the commissioner	Minn. Rules 4725.1820 Notification for Construction of Water Supply Wells
Groundwater.	Requires notification of a proposed construction of a groundwater well to the commissioner	Minnesota Statute 103I.205 Well Construction
Groundwater	Requires MDH commissioner approval for construction and modification of wells and borings within Special Well and Boring Construction Areas (SWCAs)	Minnesota Rule 4725.3650 Special Well and Boring Construction Areas - Twin Cities Army Ammunition Plant

As noted in **Table 2**, a Declaration of Restrictions and Covenants and Affidavit Concerning Real Property Contaminated with Hazardous Substances (Restrictive Covenant) is in place for the Site. Restrictive covenants are ICs that provide access and use restrictions on specific media or areas of specific media on individual properties. Restrictive covenants are transferable and binding to present and future owners of the Site until criteria for termination of the restrictive covenant is met. Historically, Minnesota has used restrictive covenants as ICs to ensure long-term protection of health and environment at risk-based cleanup sites. All new environmental covenants must conform to the Uniform Environmental Covenants Act (UECA) effective on July 1, 2007, in order to be approved by the State. UECA was developed to provide a uniform national approach to restrictive covenants. However, existing restrictive covenants under previous law remain legally valid and no significant changes would be made to the existing restrictive covenant. Therefore, modification of the restrictive covenant to UECA standards is not recommended.

The Site Restrictive Covenant (MPCA, 2004) restricts groundwater use within an area defined as the Groundwater Impacted Area. The Groundwater Impacted Area is located in the south-eastern portion of the Site and includes the area of the former absorption pit. The Site Restrictive Covenant also defines a Soil Impacted Area in the south east portion of the Site that indicates the land use shall be used for industrial/commercial purposes only and there shall be no disturbance or alteration that would expose or disturb the subsurface soils greater than 4 ft bgs. Legal descriptions were provided for the soil and groundwater areas but figures were not available at the time of this review.

In addition to the restrictive covenant applicable to the Site, Minnesota Rules and Statues require notification to the commissioner and restrictions for placement of wells including a Special Well and Boring Construction Area (SWCA), sometimes also called a well advisory. An SWCA is a mechanism used by the MDH which informs the public of potential health risks,

DRAFT-FINAL

provides for the construction of safe water supplies, and prevents the spread of contamination due to improper drilling of wells or borings.

MDH reviews permit applications for proposed wells located in a well advisory area to ensure that well water use is appropriate (i.e., no domestic water use from wells in contaminated aquifers) and that proper drilling and construction methods are followed.

The Site is within the SWCA for the Twin Cities Army Ammunition Plant (TCAAP) and is administered by MDH. A map of the TCAAP SWCA is included in **Appendix B**. VOCs in the Hillside Sand and Prairie du Chien aquifers have been detected several miles downgradient of the TCAAP site. The TCAAP well advisory would prevent the installation of any new domestic use wells in the Hillside Sand and Prairie du Chien aquifers by licensed well drillers in the vicinity of the Site.

IV.4 System Operations/Operation and Maintenance

Although the groundwater pump-out and treatment systems remain idled, as noted in the 2009 Annual Monitoring Report (AMR; Barr, 2010), "The remediation system is nearly 20 years old, and remaining original equipment is beginning to wear, leading to slightly more maintenance each year. This is not affecting overall performance of the system." and "The air stripper media was not changed in 2009. Using past performance as a guide, it is likely that the media will need to be replaced early in 2010."

According to the 2011 AMR (Barr, 2012) maintenance of the pump-out systems in 2010 prior to shut down included the following:

- Repaired caps at wells 112 and 113 and replaced a ball valve at well 113 in January.
- Repaired flow meter and replaced gasket at well 112 in March.
- Changed the air stripper media in April and repaired leaks in the air stripper tower following media replacement.
- Cleaned flow meter at well 112 in August.

The 2011 AMR also stated that submersible pumps are being used to sample the pump-out wells during the shut down period, so system maintenance is still necessary. Maintenance of the pump-out systems in 2010 following shut down included the following:

- Replaced the motor and cleaned the pump for well 112 in October (well 112 was not sampled in September due to the broken pump). The pump was reinstalled and well 112 was sampled in December.
- Replaced the heater in the air stripper tower in December. Well 110 was not sampled in December due a pipe break potentially caused by frozen conditions; the pipe was repaired and the well was sampled in January 2011.

The 2012 AMR (Barr, 2013a) states that "The pump-out and treatment system are idled but operational. The water appropriation and NPDES (National Pollutant Discharge Elimination System) permits have been and will continue to be retained." and "Minimal maintenance was required in 2012. A new pump motor and drop pipe section were installed in well 113, the air stripper tower heater was repaired, and the pump and drop pipe were re-installed in well 112 after being removed for work associated with the vapor intrusion investigation. The overall integrity of the pump-out and treatment systems is being maintained."

Although periodic monitoring and inspection of the pump-out stem is being conducted, in the event that the pump-out and treatment system is taken out of idled status, it is recommended that the permits be reviewed and entire system be thoroughly inspected and repaired with upgrades as necessary.

DRAFT-FINAL

V. PROGRESS SINCE THE LAST FYR

This section documents when follow-up actions which impact protectiveness that were noted in the previous FYR Report were implemented. Because the Fourth FYR Report was not finalized, this section will summarize the concerns from the draft Fourth FYR Report and any additional progress since that time.

As noted in the **Section IV.1.1**, in order to address vapor intrusion concerns the Consent Order was amended on March 11, 2014, "RAP Modification #1." (MPCA, 2014) Remedial actions under the RAP Modification #1 are currently underway. Implementation of RAP Modification #1 will be evaluated under the next FYR. For reference, figures presenting building vapor mitigation status and study area sub-slab sampling results greater than 20 micrograms per cubic meter ($\mu g/m^3$) as of July 23, 2014, are included in **Appendix B**.

Issues and recommendations are outlined in **Table 3**, along with follow-up actions. Additional discussion for each item is presented after the table.

Table 3: Status of Recommendations from the 2004 and 2009 FYR for the Groundwater Operable Unit

Issue	Recommendations/ Follow-up Actions	Party Responsible	Original Milestone Date	Current Status	Completion Date (if applicable)
2004 Issues presented in 2009 Review					
1. ICs are not in Place	Finalize ICs	GMI	June 2005	Completed	November 8, 2004
2. Performance standards must be revised	Amend the current Consent Order to establish new performance standards.	MPCA	December 2004	Considered but not implemented	
3. Maintain groundwater containment and monitoring systems (1)	Continue to operate, maintain and monitor the groundwater containment system to maintain protectiveness of human health and the environment.	GMI	None stated	Ongoing	
4. Potential Delisting of Site (1)	Recommend to the USEPA that the Site be deleted from the NPL.	MPCA	None stated	Considered but not implemented	
2009 Issues					
5. Groundwater monitoring indicates meeting established performance criteria	Shut down groundwater extraction system and implement approved groundwater monitoring and contingency plan	GMI	October 2009	Completed	September 13, 2010

DRAFT - FINAL

Table 3: Status of Recommendations from the 2004 and 2009 FYR for the Groundwater Operable Unit

Issue	Recommendations/ Follow-up Actions	Party Responsible	Original Milestone Date	Current Status	Completion Date (if applicable)
6. Increasing concentrations in one St. Peter monitoring well	Perform non-intrusive evaluation of factors that may contribute to increasing trends at well 203	GMI	October 2009	Completed	Barr, 2012
7. AMRs do not present data for all compounds analyzed	Present data for all analyzed compounds in AMRs	GMI	February 2010	Completed	AMR (Barr, 2012; Barr, 2013a)
8. Figures included in AMRs should be updated to include the most current information	Present long-term concentration trend analysis for all wells	GMI	February 2010	Completed	AMR (Barr, 2012; 2013a)
9. Monitoring well WW is missing a lock	Secure monitoring well WW	GMI	Immediate	Completed	August 22, 2013
10. Recommend NPL Deletion	Continue to proceed with deletion of the Site from NPL	MPCA/ USEPA	October 2009	Considered but not implemented	

(1) Issues 3 and 4 from 2004 were not identified; however, recommendations were made. Therefore, issues were formulated to reflect the recommendations

Issue 1. 2004: *"Finalize the institutional controls which will consist of a restrictive covenant. The current property owner has submitted a draft restrictive covenant for MPCA review and will record the final document with Hennepin County once it is approved by MPCA. The restrictive covenant is expected to be in place by June 2005."*

2009: A Restrictive Covenant, signed by the MPCA and GMI on September 23, 2004 (MPCA, 2004) for the Site has been finalized and recorded with Hennepin County on November 11, 2004. The restrictive covenant identifies use restrictions for identified *"Soil Impacted Areas,"* and *"Groundwater Impacted Areas."* The establishment of the restrictive covenant satisfies the recommendation from the previous FYR to finalize ICs.

Issue 2. 2004: *"Amend the current Consent Order to establish new performance standards and to clarify the objective of the remedy as plume containment. This amendment is expected to be finalized by December 2004."*

2009: At the time of this review, the Consent Order has not been amended. The MPCA has determined the remedial objective to reduce plume migration is clearly stated in the Consent Order.

Issue 3. 2004: *"Continue to operate, maintain and monitor the groundwater containment system to the extent necessary to maintain protectiveness of human health and the environment. The*

DRAFT-FINAL

effectiveness of the groundwater containment system should continue to be evaluated on an annual basis in the AMR with the intent of revising the system as needed."

2009: During this review period GMI continued operations and maintenance of the groundwater extraction wells and treatment system. GMI also continued groundwater monitoring to evaluate the effectiveness of the containment remedy and evaluate progress toward meeting performance standards for the Site.

Issue 4. 2004: *"Recommend to EPA that the Site be deleted from the NPL once the Consent Order is amended and institutional controls are put in place."*

2009: ICs have been implemented and address for both soil and groundwater at the Site. The MPCA has recommended the Site for deletion from the NPL prior to this review period.

Issue 5. 2009: *"Groundwater monitoring indicates meeting established performance criteria. Recommend shutting down groundwater extraction system and implement approved groundwater monitoring and contingency plan."*

2014: The groundwater pump-out and treatment system was placed on idled status on September 13, 2010. Groundwater water monitoring is currently being conducted in accordance with the approved groundwater monitoring plan. Details on the system shutdown are presented in the *Groundwater Pump-out System Shutdown Summary Report and 2011 Annual Report* (Barr, 2012). Additional monitoring results are reported in the 2012 AMR (Barr, 2013a).

Issue 6. 2009: *"Increasing concentrations in one St. Peter monitoring well. Recommend performing non-intrusive evaluation of factors that may contribute to increasing trends at well 203.*

2014: An evaluation of well 203 was performed in *the Groundwater Pump-out System Shutdown Summary Report and 2011 Annual Report* (Barr, 2012). The TCE concentrations in samples from well 203 increased starting in about 2000, peaked in 2006 and 2007 at 40 µg/L, and have been decreasing since. The sample from well 203 from September 2010 contained 21 µg/L TCE. Based on the low concentrations, no further action is an appropriate response (Barr, 2012).

Issue 7, 2009: *"AMRs do not present data for all compounds analyzed. Recommend presenting data for all analyzed compounds in AMRs".*

2014: The 2011 and 2012 AMRs include laboratory reports identifying all analysis performed. However, a summary of all the compounds detected were not presented in figures.

Issue 8. 2009: *"Figures included in AMRs should be updated to include the most current information. Recommend presenting long-term concentration trend analysis for all wells."*

2014: The 2011 and 2012 AMRs include graphs, tables and figures containing the most current information. Graphs and tables containing historical and current information for groundwater levels and TCE fluctuations were also presented. Long-term trend analysis (i.e., such as a statistical analysis - Mann-Kendall Trend analysis) was not performed.

Issue 9. 2009: *"Monitoring well WW is missing a lock. Secure monitoring well WW."*

DRAFT FINAL

2014: No records were found regarding placement of the WW lock. However, WW was abandoned on August 22, 2013 (Barr, 2014).

Issue 10. 2009: *"Recommend NPL Deletion; Continue to proceed with deletion of the Site from NPL."*

2014: Deletion from the NPL was not implemented. As noted in Section IV.1.1, under the March 11, 2014, "RAP Modification #1" (MPCA, 2014), GMI is currently performing investigation and soil gas mitigation activities at and in the vicinity of the Site to address potential vapor intrusion risks associated with the VOCs in the groundwater.

DRAFT-FINAL

VI. FIVE-YEAR REVIEW PROCESS

This section describes the activities performed during the FYR process and summarizes the findings where appropriate.

VI.1 Administrative Components

On April 4, 2014, MPCA initiated the Fifth FYR process. The Site FYR was led by David Scheer, Senior Hydrologist of the MPCA's Remediation Division. Leah Evison and Jennifer Cheever, of the USEPA assisted in the review as the representative of the support agency. In addition, GMI representative Larry Deeney, landowners in vapor study area, and the Southeast Como Improvement Association (SECIA) were contacted on April, 25, 2014, to notify them of the upcoming FYR, establish members of the review team, and develop a review schedule.

The review consisted of the following components:

- Community Involvement;
- Document Review;
- Data Review;
- Site Inspection; and
- FYR Report Development.

VI.2 Community Notification and Involvement

Activities to involve the community in the FYR process were initiated with notifying SECIA and inviting SECIA representatives to the May 1, 2014, Site Inspection. A notice was published in the following websites and local newspapers stating that there was a FYR and inviting the public to submit any comments to the MPCA:

- MPCA Website;
- SECIA Website;
- Minneapolis Star Tribune; and
- Minnesota Daily.

A copy of each notification is included in **Appendix C**. The public comment period ended on July 7, 2014. The comments and concerns received, along with MPCA responses, are included in **Appendix C.**

Comments were received from:

SECIA: Comments received from the SECIA include a "Removal Request" for soil excavation to be performed in the former absorption pit area. In an MPCA response letter MPCA summarizes historical (Barr, 2001) sampling event did not that did not find TCE soil contamination that justified soil removal and more recent sample event (Barr, 2014a) did not find TCE contamination in the upper 30 ft within the former absorption pit. The MPCA concluded that excavation of the former soil absorption pit area would not provide an overall environmental benefit or health risk reduction to residents.

Judith Treise: This resident expressed her overall concern that the Site has been neglected and a failure of government to do its job.

Additional community notification and involvement activities are currently being performed as part of the soil gas investigation and sub-slab mitigation activities.

DRAFT FINAL

VI.3 Document Review

A list of documents reviewed for the preparation of this FYR is included in **Appendix D.** The Consent Order, previous FYR reports, and Annual LTM Reports since the last FYR were the primary documents reviewed. RAOs, applicable or relevant and appropriate requirements (ARARs) and cleanup levels used to ensure the groundwater remedy is protective of human health and the environment were obtained from the 1984 Consent Order. A Decision Document/Record of Decision has not been completed for this Site.

VI.4 Data Review

This section presents a summary of the documents and data reviewed in preparation of this FYR. AMRs submitted during the review period include:

- 2009 Annual Monitoring Report (AMR; Barr, 2010)
- 2010 AMR (Barr, 2011)
- Groundwater Pump-out System Shutdown Summary Report And 2011 Annual Report (Barr, 2012)
- 2012 AMR (Barr, 2013a)
- 2013 AMR (Barr, 2014a)

In addition, the *Draft Vapor Intrusion Pathway Investigation and Feasibility Study Work Plan Sampling and Monitoring Work Plan*, June (Barr, 2014b) contained updated information on geology and recent groundwater monitoring results. A summary of these reports are discussed in the following subsections. Supporting tables and figure are included in **Appendix B.**

VI.4.1. Groundwater Extraction and Pump-Out System Monitoring

The groundwater pump-out and treatment systems operated at the Site for over 25 years. Five pump-out wells (109, 110, 111, 112, and 113) are screened in the glacial drift. Wells 109 and 110 are located nearest to the former absorption pit area and comprise the on-site glacial drift pump-out system. The downgradient glacial drift pump-out system consists of wells 111, 112, and 113. Two pump-out wells (MG1 and MG2) are screened in the Magnolia member of the Platteville bedrock formation. When the pump-out system is operational, water from wells 109 and 110 is treated by the on-site air stripper prior to discharge to the storm sewer, and water from the remaining five pump-out wells discharges directly to the storm sewer. (Barr, 2012)

The pump-out system removed approximately 6.6 billion gallons of groundwater and removed approximately 7,000 pounds (570 gallons) of TCE from the groundwater during 25 years of operation. Annual TCE removal peaked at 660 pounds per year in 1987, and decreased exponentially to a near-constant average of 150 pounds per year from 2006 to 2010. (Barr, 2012)

In accordance with the Consent Order, the pump-out systems were designed as follows:

- The on-site glacial drift pump-out system was designed to remove groundwater with the highest TCE concentrations in the glacial drift.
- The downgradient glacial drift pump-out system was designed to remove groundwater in the glacial drift with TCE concentrations greater than 270 micrograms per liter (µg/L).
- The Magnolia pump-out system was designed to remove groundwater in the Carimona and Magnolia members with TCE concentrations greater than 27 µg/L.

DRAFT-FINAL

GMI and Barr met with the MPCA on June 23, 2010 regarding GMI's desire to seek the delisting of the Site from the Minnesota PLP and achieve closure. MPCA suggested shutting down the groundwater pump-out systems for a period of approximately one year and evaluating groundwater conditions. The pump-out systems were shut down on September, 13, 2010, in accordance with an MPCA approved plan. A comprehensive pump-out system shut down report was prepared in conjunction with the 2011 AMR (Barr, 2012) that detailed the events and monitoring results.

The 2013 AMR indicated that "The groundwater pump-out and treatment systems remained shut down in 2013. Submittal of quarterly "No Discharge" Discharge Monitoring Reports (DMRs) continued in 2013 under the National Pollutant Discharge Elimination System (NPDES) permit for the Site (MN0056022). The Minnesota Department of Natural Resources water appropriations permit is being maintained while the groundwater pump-out system is idle." (2014a, Barr)

Generally, groundwater flow direction has reverted to pre-1985 conditions following the shutdown. The exception is the Carimona member, where the flow pattern remains similar to what it was during the years of pumping. TCE concentrations in the glacial drift and Magnolia member pump-out wells decreased approximately 70 to 80% since the pump-out and treatment system began operation until the shutdown. The treatment system worked most effectively in the first three to five years of operation and significantly reduced TCE concentrations in the pump-out wells. (Barr, 2012)

The pump-out and treatment systems are idled but remain operational. Currently, the long-term operation and monitoring plan includes the collection and analysis of samples from selected monitoring and pump-out wells once every five years. The recommended monitoring plan is summarized in **Appendix B**, labeled Table 3. (Barr, 2012)

VI.4.2. Groundwater Monitoring

The existing monitoring well network and Site layout are shown on **Figure 1.** In addition to the seven pump-out wells, the existing monitoring well network includes 23 wells (7 of which are pump-out wells) screened in the following geologic units: the glacial drift, the Carimona member of the Decorah Shale, the Magnolia member of the Platteville Limestone, the St. Peter Sandstone, and the Prairie du Chien Group. Over time, as the extent of impact was determined, and as the effectiveness of the pump-out systems was verified, the monitoring well network was reduced, including abandonment of eleven groundwater wells in August 2013 (Barr, 2014a) and all but 16 remaining monitoring wells have been abandoned. A complete list of existing and abandoned wells is included in **Appendix B**.

Historical groundwater trends and TCE results (Barr, 2013a and 2014a) are included in tables and graphs in **Appendix B.** Groundwater levels in all aquifers measured during the 2012 groundwater monitoring event were consistent with historic data and trends. Groundwater flow directions in the monitored aquifers are consistent with historical results. The lateral flow direction in the Carimona confining unit changed in the late 1980s in response to pumping and, as of the groundwater monitoring event conducted in December 2012, the flow direction remained consistent with the direction measured in the pumping period and has not yet reverted to the pre-pumping condition. As the Carimona is a confining unit, groundwater flow likely has a strong vertical component and the lateral flow is less important than in the other units being measured. (Barr, 2013a)

The average depth to groundwater is approximately 15 to 25 ft bgs, with an approximate saturated thickness of the glacial drift of 20 to 25 ft. Water table contours as measured in April 2014 are shown in **Appendix B** (labeled Figure 8). The horizontal groundwater flow direction in

DRAFT FINAL

the glacial drift across the Site and surrounding area has been consistently southwest, based on the last 29 years of monitoring data (Barr, 2013a). Hydrographs of water-level data from the glacial drift monitoring wells show relatively stable water level trends (Barr, 2013a).

Glacial Drift Wells. TCE concentrations in the samples from the glacial drift wells during the groundwater monitoring event were below the TCE limit (270 µg/L) set forth in the Consent Order. Temporal trends in TCE concentrations in groundwater at the glacial drift wells **Appendix B** (labeled Figure 13 and 14) during the shutdown period are as follows:

- Continuing non-detectable TCE concentrations in groundwater at wells 111, Q, T, and X;
- Declining TCE concentrations in groundwater at well S (110 µg/L; 12/10/2009 to 73 µg/L; 12/19/2012), well V (58 µg/L; 3/3/2011 to 31 µg/L; 12/17/2012), well 112 (38 µg/L; 2/4/2010 to 5.4 µg/L; 1/16/2013), and well 113 (78 µg/L 9/22/2010 to 4.5 µg/L; 12/18/2012);
- A possible increase in TCE concentrations in groundwater at well 109 (120 µg/L 9/22/2010 to 160 µg/L; 12/18/2012) well W (5.2 µg/L; 6/16/2011 to 6.8 µg/L; 12/17/2012) and well 110 (100 µg/L: 9/22/1010 to 230 µg/L; 1/17/2013); however, the concentrations remain below the applicable limits in the Consent Order. (Barr, 2013a)

Carimona Wells. The Carimona wells were not sampled during 2012, however temporal trends of TCE concentrations at the Carimona wells have been generally steady for many years (Barr, 2013a). As a result, MPCA approved the sealing of all Carimona monitoring wells in August 2013. TCE concentrations in the Magnolia member wells during the groundwater monitoring event were below the TCE limit (27 µg/L) set forth in the Consent Order. Temporal trends of TCE concentrations at the Magnolia wells **Appendix B** (labeled Figure 16) during the groundwater monitoring event were:

- a continuing non-detectable TCE concentration at well TT
- a continuing steady TCE concentration at well 14 (5.3 µg/L12/17/2010 to 4.2 µg/L; 12/19/2012);
- a decrease in the TCE concentration at well MG-1 (12 µg/L; 2/4/2010 to 6.5 µg/L; 12/19/2012); and
- a possible increase in the TCE concentration at well MG2 (2.6 µg/L; 2/4/2010 to 13 µg/L; 12/18/2012); however, the concentration remains below the applicable limit in the Consent Order. (Barr, 2013a)

St. Peter Sandstone. Recent trends of steady to declining concentrations at well 200 (5.3 µg/L; 9/22/2010 to 5.3 µg/L; 12/18/20120) and well 203 (21 µg/L; 9/22/2010 to 19 µg/L; 12/18/2012) in the St. Peter Sandstone continued during the groundwater monitoring event. (Barr, 2013a) **Appendix B** (labeled Figure 18).

Prairie du Chien Group. The Prairie du Chien Group is separated from the glacial drift by three confining units. Consistent TCE concentrations in the Prairie du Chien have been measured in recent years. The Prairie du Chien aquifer in this area has been impacted by the release of TCE at the TCAAP Site in Arden Hills. Prairie du Chien monitoring was not part of the monitoring program in 2012. The Prairie du Chien well at the site is an inactive industrial production well; there are no plans for future use of this well. (Barr, 2013a)

Potentiometric head differences between the glacial drift and wells finished in underlying bedrock (lower Carimona Member of the Decorah Shale) indicate that where present, the clay till and/or the upper bedrock units of the Decorah Shale act as a confining unit, restricting vertical groundwater flow between the glacial drift and lower bedrock units (Barr, 1983; Runkel

DRAFT-FINAL

et al., 2003). Hydraulic head differences between wells finished in the glacial drift and the bedrock during operation of the pump-out system indicated downward vertical hydraulic gradients between the glacial drift and the bedrock of approximately 0.3 to 0.4 ft per ft (ft/ft) (Barr, 2013a). Several measurements of the hydraulic conductivity of the glacial drift have been completed. A pumping test at pump-out well 109 on the Site indicated a hydraulic conductivity of 2×10^{-3} centimeters per second (cm/sec) (Barr, 1985). Values ranging between 2×10^{-3} to 5×10^{-2} cm/sec were estimated based on approximations using the Hazen method utilizing grain size data from borings across the Site (Barr, 1985). Based on this range, an estimated hydraulic gradient of 0.01 ft/ft from the 2014 water table contours and an effective porosity estimate of 0.3, the ambient horizontal groundwater flow velocity is estimated between 70 and 2,000 ft per year (ft/yr). (Barr 2014b)

VI.4.3. Soil

Several soil investigations have been performed in the former soil absorption pit area. The two most recent investigations are summarized in the 2001 report (Barr, 2001) and Disposal Area Investigation Results (Barr, 2014b). Figures were developed and presented in the *Draft Vapor Intrusion Pathway Investigation and Feasibility Study Work Plan* (2014 Work Plan; Barr, 2014c) and are included in **Appendix B**. The Figure labeled Figure 15 presents a compilation of historical boring locations. The 2001 investigation work was performed to better characterize the possible existence of contaminant in the soil within the accessible (0-4 ft bgs) and potentially accessible zones (5-12 ft bgs) in the absorption pit area. All soils were field screened for volatile organic vapors and 30 soil samples were selected for laboratory analysis. TCE was not detected above the Tier 2 SRV (46 milligrams per kilogram [mg/kg]) in the 30 soil samples analyzed. TCE was not detected above the Tier 1 SLVs (0.14 mg/kg) in GP-1, the boring advanced nearest to the former absorption pit.

The Disposal Area Investigation Results (Barr, 2014b) summarized the results of four soil borings (DP-054 through DP-057) advanced in May of 2014 to verify whether TCE contamination is present in the soil. The four boring locations are shown on a figure in **Appendix B** (labeled Figure 1). Boring DP-054 was placed as close as possible to the location of the former soil absorption pit area based on the presence of buried utilities. Borings DP-055, DP-056 and DP-057 were then placed 30 to 40 ft west, east and south of the soil absorption pit area, respectively. The stratigraphy observed in the soil borings generally consisted of 10 to 16 ft of topsoil and peat fill at the surface, underlain by sand with occasional gravel lenses. The presence of peat fill indicates that this area may have been excavated in the past. Clay till was encountered in each of the general drilling locations beginning between 39 and 42 ft bgs at elevations ranging from 816.5 to 819.5 ft above msl. This investigation did not find TCE contamination in soil samples collected in the shallow depths (upper 30 ft) of the former soil absorption pit area. Low level TCE (less than 1 mg/kg) was found in the soil at depths between approximately 40 and 53 ft bgs in the former soil absorption pit area (Barr, 2014b).

VI.4.4. Vapor Intrusion Pathway

In accordance with the RA Modification #1, a vapor intrusion pathway investigation and sub-slab soil gas mitigation system activities have been ongoing since April 2012. Although review of these activities will be conducted during the next FYR, data generated was used in the evaluation of the groundwater remedy. This data along with plans for proposed Site investigation activities, are presented in the 2014 Work Plan (Barr, 2014c). Copies of updated tables and figures, including geologic maps, cross sections, and existing and abandoned wells from the this work plan are included in **Appendix B**. Proposed work includes the installation of 26 additional glacial drift groundwater monitoring wells to add to the 13 existing glacial drift

DRAFT-FINAL

monitoring and pump-out wells. These wells are identified in **Appendix B** (labeled Table 2) and include one nested well in the former absorption pit area (labeled Figure 15).

VI.4.5. Receptor Well Survey

The Consent Order indicates five industrial wells in the area were sampled as part of the initial investigation. Sampling results indicated that VOC concentrations were not detected in four of the five wells sampled and concentrations detected in the fifth well were below drinking water quality criteria. A receptor survey conducted in 1997 identified 21 wells (not including Site associated wells) downgradient of the Site, in the area between the Site and the Mississippi River (approximately 1 mile). Evaluation of the downgradient wells concluded 18 of the 21 wells were either abandoned or not in service. Two of the three remaining wells were utilized by the University of Minnesota for dewatering purposes near an underground structure. The third well was also utilized by the University of Minnesota for a source of water for a deionization process and is not connected to the buildings potable water supply system. Potable use of groundwater downgradient of the Site has not been identified.

Another receptor survey was completed and reported in the 2012 Receptor Survey. In summary, wells listed as "active" that were found in the 2012 Receptor Well Survey are either used for dewatering purposes or are not connected to potable water supply services. Therefore, these wells do not pose a risk to human health or safety. The 2012 search area used was the same as in 1997 (Barr, 2013a).

VI.5 Site Inspection

On May 1, 2014, a Site inspection was conducted with representatives from MPCA, USEPA, GMI, Barr, Bay West, landowner, and SECIA. A site inspection summary form along with a sign in sheet identifying the inspection participants is included in **Appendix E**. The purpose of the inspection was to assess the protectiveness of the remedy. The overall observations from the site inspection include:

- The groundwater remedy was designed to contain the contaminant plume. The pump-out and treatment systems were shut down in 2010. According to Barr, at the time of the inspection, periodic groundwater monitoring indicates the groundwater plume remains stable/receding and contaminant concentrations are declining. Institutional controls are in place that restrict disturbance of soils below 4 ft in the vicinity of the former adsorption pit and installation of groundwater drinking water wells in the affected aquifers. Therefore, the groundwater remedy is effective and functioning as designed.
- All existing pump-out and monitoring wells were located (**Figure 1**) and inspected. Representative photographs were taken of each well and are included on **Figures 2** and **3.** A well inventory sheet listing all existing wells is included in **Appendix E**. As noted in the well inventory form, several wells require maintenance. These wells are only inspected during the groundwater monitoring event (currently every five years). Annual well inspection and repair, as necessary, is recommended.
- The groundwater LTM program calls for sampling of existing monitoring well network every five years as approved by the MPCA. Vapor intrusion assessment activities should evaluate whether pump-out and treatment system will enhance existing vapor mitigation activities.

VI.6 Interviews

During the FYR process, interviews were conducted with several stakeholders and government officials involved in Site activities and/or that are aware of the Site. The purpose of the interviews was to document the opinions on perceived problems or successes with the remedy

DRAFT FINAL

that have been implemented to date. A list of individual contacted and interviewed are included in **Appendix F** along with a detailed summary of the interviews.

The overall general sentiment is that the project was moving along smoothly until the potential risk from the vapor intrusion pathway came to light. As a result, there is concern that the groundwater plume needs further delineation to aid in the evaluation of the vapor intrusion pathway.

DRAFT-FINAL

VII. TECHNICAL ASSESSMENT

VII.1 Question A: Is the remedy functioning as intended by the decision documents?

VII.1.1. Remedial Action Performance

The pump-out and treatment systems were shut down on September, 13, 2010, in accordance with an MPCA-approved plan, after 25 years of operation. The pump-out and treatment systems removed approximately 6.6 billion gallons of groundwater and removed approximately 7,000 pounds (570 gallons) of TCE from the groundwater during 25 years of operation. Annual TCE removal peaked at 660 pounds per year (lb/yr) in 1987, and decreased exponentially to a near-constant average of 150 lb/yr from 2006 to 2010. (Barr, 2012)

Groundwater monitoring indicates that the idled pump-out and treatment systems continue to meet the RAOs and cleanup levels as specified in the Consent Order:

- The on-site glacial drift pump-out system was designed to remove groundwater with the highest TCE concentrations in the glacial drift.
- The downgradient glacial drift pump-out system was designed to remove groundwater in the glacial drift with TCE concentrations greater than 270 µg/L. The most recent sampling event indicated the highest concentrations have been detected at well 110 (230 µg/L; 1/17/2013).
- The Magnolia pump-out system was designed to remove groundwater in the Carimona and Magnolia members with TCE concentrations greater than 27 µg/L. The most recent sampling event indicated the highest concentrations have been detected at well MG2 (13 µg/L; 12/18/2012).

However, an increase in TCE concentrations in recent sampling events indicates an increase in contaminant concentrations may be occurring.

VII.1.2. System Operations/O&M

As noted in the well inventory form (**Appendix F**), several monitoring and pump-out wells require maintenance. These wells are only inspected during the groundwater monitoring event (currently every five years).

The pump-out and treatment system are idled but operational. The water appropriation and NPDES permits have been and will continue to be retained. The overall integrity of the pump-out and treatment systems is being maintained. (Barr, 2013a)

VII.1.3. Opportunities for Optimization

Annual well inspection and repair, as necessary, is recommended. Although periodic monitoring, inspection and repair of the pump-out and treatment systems are being conducted (currently proposed for every five years), in the event that the pump-out and treatment systems are taken out of idled status, it is recommended that the entire system be thoroughly inspected and repaired with upgrades as necessary.

GMI is currently performing investigation and soil gas mitigation activities at and in the vicinity of the Site to address potential vapor intrusion risks associated with the VOCs in the groundwater. Because soil gas mitigation activities are needed to address the potential vapor intrusion risks associated groundwater RAOs and cleanup levels presented in the Consent Order should be evaluated for this pathway. Limitations of the pump and treat technology should be examined (see discussion below) and other response actions evaluated and possibly implemented rather

DRAFT FINAL

than only considering taking the pump-out and treatment systems out of idled status. LTM should include MNA evaluation parameters and an assessment of biodegradation to determine whether bioremediation/enhanced bioremediation/bioaugmentation would be effective in treating the impacted groundwater to levels that would be protective of human health and the environment, including the vapor intrusion pathway.

Pump and Treat Technology Limitations. Although historically, pump and treat technology has often been the selected technology for aquifer remediation, an increasingly large body of evidence suggests that this method is not always effective. One of the major disadvantages of pump and treat is that the degree of contaminant removal is highly dependent on the chemical nature of the contaminant and the subsurface geology. Sites where the contaminants are in a mobile, dissolved state and minimal sorption has occurred are best for pump and treat remediation (Nyer, 1993).

The difficulties encountered with contaminant chemistry and subsurface geology often increases the cost and time required to adequately remediate the Site. A summary of the potential disadvantages of using pump and treat technology follows:

- Effectiveness varies with the nature of the contaminant (e.g., dissolved-phase vs. sorbed).
- Effectiveness is decreased if contamination is not caught early (e.g., still in mobile phase).
- Effectiveness is affected greatly by subsurface geology (e.g., homogeneous vs. heterogeneous lithology and high permeability vs. low permeability soil).
- The technology can be very costly depending on extraction rates and pore volumes requiring treatment.
- It is often a slow process, especially when sorbed contamination is present and continues to “leach” into the dissolved-phase plume. This statement is consistent with conditions at this Site, where implementation of the pump and treatment system in the glacial drift aquifer continued for approximately 25 years prior to reaching the Consent Order RAO remediation goal of 270 µg/L.
- It can be difficult to achieve cleanup to standards for drinking water and vapor intrusion pathways.
- Pump and treat technology cannot effect the rate of contaminant back diffusion (re-suspension of contaminants bound up in low permeability soils).

Additional factors come into play when considering the potential use of pump and treat for aquifer remediation. Remediation by pump and treat is a slow process and cleanup times are often very long. System design, such as pumping rate, is one factor to consider when estimating cleanup times. A system pumping at very low rates may have a very long predicted cleanup time. Note that estimating cleanup times is difficult and is subject to a large number of uncertainties; typical methods used to calculate cleanup time often result in underestimates because they neglect processes that can add years to the cleanup. Simple calculations for a variety of typical situations show that predicted cleanup times range from a few years to tens, hundreds and even thousands of years (Kavanaugh, et. al.,1994).

Because pump and treat cost is largely based on the uncertain time required for cleanup, the technology is often not the most feasible choice for remediation. And to a large extent, the feasibility of groundwater cleanup depends on the cleanup goals and requirements. Returning groundwater to drinking water standards may not be possible at many sites. Pump and treat

DRAFT FINAL

groundwater remediation, while successful in containing contaminated groundwater plumes and reducing the concentration of groundwater contaminants, cannot always be relied on to bring contaminant levels down to environmentally accepted standards (Nyer, 1993). While pump and treat designs can be effective at sites where the contaminant is still in the free-phase stage and the subsurface is relatively homogeneous, most remediation projects have a high degree of uncertainty. In order to adequately remediate Site groundwater and meet vapor intrusion standards, pump and treat technology alone will not be adequate.

VII.1.4. Early Indicators of Potential Issues

Review of TCE results (see tables and graphs in **Appendix B**) indicate an increase in contaminant concentrations in some of the wells including the source area glacial drift pump-out wells 109 and 110 since system shutdown. Although levels are still below the Consent Order action levels of 270 µg/L, concentrations at pump-out well 110 have more than doubled from 100 µg/L on September 22, 2010 to 230 µg/L on January 17, 2013, since the pump-out system was shut down, indicating an increase in contaminant concentrations may be occurring. Therefore, groundwater monitoring more frequently than once every five years, as proposed in the AMR, is recommended until TCE results exhibit a stable or receding plume. In addition, a statistical analysis (e.g. Mann-Kendall Trend analysis) is recommended to support statements concerning increases, decreases, or stable concentrations over time.

The recent Draft Vapor Intrusion Pathway Investigation and Feasibility Study Work Plan proposes installing 26 additional glacial drift monitoring wells including one nested well in the former absorption pit area (**Appendix B**, Figure 15; Barr, 2014c) to augment the 13 existing glacial drift monitoring and pump-out wells. Available data suggest that the former soil absorption pit is not a continuing source of TCE in shallow groundwater. However, vertical characterization of deeper (.15 ft bgs) soil and groundwater is recommended

VII.1.5. Implementation of Institutional Controls and Other Measures

The property is surrounded by an unsecured fence and the landowner is aware of the ICs; there are no access restrictions in place or other physical measures indicating the outline of the Soil Impacted Area. In addition, figures depicting the restricted areas were not available in the copy of the IC on file at the MPCA. The legal description alone is not adequate to identify:

- Groundwater Impacted Area located in the south eastern portion of the Site and includes the area of the former absorption pit; and
- Soil Impacted Area in the south east portion of the Site.

A figure with geographic information system (GIS) coordinates should be developed and readily available in the event that construction within the impacted areas is proposed.

VII.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

VII.2.1. Changes and Standards To Be Considered

No changes in the federal standards were identified in this five-year period. The drinking water standard (Maximum Contaminant Level [MCL]) for TCE remains 5 µg/L, a value that is as close as practical to the Maximum Contaminant Level Goal (MCLG), which is set at zero by the USEPA Office of Drinking Water for all carcinogens. The MDH established Health Risk Limit (HRL) for TCE is 5 µg/L, which is consistent with the federal MCL for this compound. In May of 2013, MDH developed health based values (HBVs) for TCE including cancer (2 µg/L), short-term (0.4 µg/L), chronic (0.4 µg/L) and subchronic (0.4 µg/L). Remedial actions at the site had

DRAFT-FINAL

previously focused on the use of groundwater, and through the imposition of ICs, groundwater use is no longer a concern.

Recent concerns have been raised about the TCE concentrations in the shallow groundwater and the potential vapor intrusion pathway posed to buildings in the vicinity of the Site. In assessing this exposure pathway, MDH and MPCA have established a residential Intrusion Screening Value (ISV) of 2 µg/m^3 of TCE in indoor air. This level is "considered safe to breathe every day for a lifetime, even for potentially sensitive populations, such as young children or pregnant women" (MDH, 2014). An industrial ISV of 6 µg/m^3 has also been established by the MPCA for TCE. Both the residential and industrial ISVs can be considered "To Be Considered values. The residential and industrial ISVs were revised to their current numbers based on toxicity data released by EPA's Integrated Risk Information System (IRIS) in September of 2011. As noted previously, the vapor intrusion pathway is being addressed through RAP Modification #1 to the Consent Order and will be assessed in more detail in the next FYR.

VII.2.2. Changes in Exposure Pathways

Groundwater

The focus of the initial remedial action was the control of risks that might result from the use of groundwater as a source of drinking water. The cancer risk value for TCE in effect in 1984 resulted in a 10^{-6} (one-in-one million) cancer risk at a concentration in drinking water of 2.7 µg/L. USEPA suggested that cleanup at Superfund sites should result in a risk in the range of 10^{-4} to 10^{-6}, or drinking water levels between 270 µg/L and 2.7 µg/L, and it seems likely that the target risk levels of 270 µg/L for shallow aquifers and 27 µg/L for deeper aquifers at the Site were based on these values. The differences between the target risk levels for the two aquifers reflects the fact that the deeper aquifer is more likely to be used as a source of potable water, and consequently, a lower target risk level would be warranted for this aquifer.

Groundwater is no longer considered to be a source of potable water and ICs are in place to ensure that such use does not occur. Therefore, with the implementation of the ICs, the regular use of groundwater as a source of potable water is no longer an exposure pathway at the site.

Vapor Intrusion

The potential for constituents in groundwater to migrate through vadose zone soils and enter the indoor air of buildings is termed vapor intrusion. For the Site, the presence of TCE in shallow groundwater and the location of the Site in a residential area have resulted in vapor intrusion pathway being recognized as a concern. As a result, recent investigation and remedial activities at the Site, addressed in RAP Modification #1 to the Consent Order, have shifted from concerns about the potential use of groundwater as a source of potable water to a focus on the potential for exposure via vapor intrusion and the inhalation pathway. The residential ISV of 2 µg/m^3 discussed above is multiplied by a default attenuation factor of 10 to arrive at an equivalent screening value for sub-slab (samples collected beneath the floor of the building) soil gas of 20 µg/m^3. Concentrations exceeding the MDH and MPCA residential screening level for TCE in soil gas of 20 µg/m^3 have been measured in many houses in the neighborhood near the Site.

Under RAP Modification #1 to the Consent Order, soil sub-slab vapor mitigation systems are being installed in many houses. These systems typically involve venting the sub-slab soil gas into the air above the building. The TCE released into the outdoor air via the venting system is likely to rapidly be dispersed by wind and diluted by the ambient air. However, some monitoring of the TCE levels in outdoor air near these systems would appear to be warranted.

DRAFT FINAL

Air

In the past, an air stripper was used to remove TCE and other VOCs from groundwater that was pumped from glacial drift aquifer extraction wells at the Site, piped to the former GM facility, and passed through the air stripper to remove VOCs. Over 95% removal efficiency was typically achieved, and the VOCs removed were exhausted into the air through an exhaust stack near the former GM facility. Substantial dilution typically occurs quickly for constituents released into outdoor air, particularly when released via a stack located at least 25 ft high (as required in the Consent Order) and this pathway generally had not been considered to contribute substantially to health risks near a site. However, based on the recent (USEPA, 2011) changes to inhalation toxicity and risk values, evaluation of past exposures via this pathway may be warranted to fully assess cumulative exposure to nearby human receptors. The air stripper is no longer in use at the site, and consequently exposure via this pathway no longer occurs. If future plans include the reuse of this stripper, emission modeling and exposure and risk evaluation would be warranted.

Soil

According to the most recent investigation in the former soil absorption pit area (Barr, 2014b)TCE contamination was not detected in soil samples collected in the shallow depths (upper 30 ft) in this area. Low level TCE (less than 1 mg/kg) was found in the soil at depths between approximately 40 and 53 ft bgs in the former soil absorption pit area (Barr, 2014b). Consequently, the potential for contact with TCE and VOCs in soil has been, and remains, limited and as a result the potential for exposure and risks is very low. In addition, land use restrictions are in place to ensure that any future activities at the site (such as future subsurface construction) do not inadvertently result in exposure to VOCs in soil.

VII.2.3. Changes in Toxicity and Other Contaminant Characteristics

Toxicity – Non-cancer effects

TCE had primarily been considered a central nervous system depressant following acute or chronic exposure by both ingestion and inhalation. Industrial use of TCE also resulted in dermatitis from exposure to vapors of concentrated solvent. More recently, concern has focused on kidney toxicity and effects on the developing fetus. In 2011, USEPA released revised toxicity factors for TCE based on years of review of toxicity studies. The information is provided online on the USEPA (2011) IRIS database. In summary, the value is greater than the drinking water standard MCL for TCE of 5 µg/L, indicating that the non-cancer risk is not the basis for the MCL.

USEPA also established an inhalation reference concentration (RfC) for TCE of 2 $\mu g/m^3$, with this value based on cardiac malformations in the developing fetus, and on immune system effects. The potential for effects on the developing fetus is of particular concern, as effects would be associated with a short duration of exposure (i.e., during the period when the heart is developing in the fetus).

Cancer Risk

USEPA (2011) has updated its IRIS database on the carcinogenicity of TCE as well. TCE has been classified by USEPA as “carcinogenic to humans” based on convincing epidemiological evidence of a causal association between TCE exposure and kidney cancer, less convincing evidence of other cancer is humans, and supporting evidence from studies in animals. Target drinking water levels based on risk would need to be modified accordingly.

USEPA (1994) had derived a cancer slope factor of $6x10^{-3}$ $(mg/kg/day)^{-1}$ for inhalation exposure to TCE. More recently, USEPA has provided cancer risk values for inhalation risk in terms of a unit risk, risk associated with a unit amount of the carcinogen in air. USEPA (2011) has updated

DRAFT FINAL

this value to a unit risk value is 4 x 10^{-5} $(\mu g/m^3)^{-1}$ or an increase of 24-fold. This updated unit risk value equates to continuous lifetime exposure to air at 0.025 $\mu g/m^3$ of TCE resulting in a 10^{-6} risk level.

VII.2.4. Changes in Risk Assessment Methods

In 2005, USEPA determined that for certain carcinogens that were mutagenic, there was an increased susceptibility in early life. For such carcinogens, USEPA (2005) determined that an Age-Dependent Adjustment Factor (ADAF) should be added to account for this increased susceptibility. For TCE, USEPA was somewhat equivocal on the use of this factor but did note that use of the ADAF became increasingly important as the proportion of exposure during early life increased. The ADAFs recommended by USEPA are 10 for exposure at less than 3 years old and 3 for 3 years old to 16 years old, with no adjustment after that age.

It should be noted that the use of ADAFs has not been uniformly accepted by states. In particular for a chemical such as TCE with even USEPA equivocating on their use, care should be taken in applying these values. The use of ADAFs results in more health protective values than the use of the unadjusted cancer slope factors or unit risks.

VII.2.5. Expected Progress Towards Meeting RAOs

The primary RAOs for this site (as noted in Section IV.1) are the containment of VOCs and in particular TCE (i.e., the minimization of the further spread of VOCs in groundwater) and a decrease in the concentration of these constituents in groundwater over time. The remedial action at the Site (groundwater pump-out and treatment) achieved the Consent Order RAOs and cleanup levels and is currently in idled status. LTM is ongoing to monitor for potential increase of TCE. The ultimate purpose of the RAOs was to prevent exposure and risks to humans through the use of groundwater as a source of potable water. ICs have been implemented to prevent groundwater use, and therefore, the ultimate objective of the remedial action, i.e., preventing exposure through groundwater use, may have been achieved.

An increased focus on the TCE concentrations in the shallow groundwater and the potential vapor intrusion pathway posed to buildings in the vicinity of the Site has resulted in investigation of this potential pathway at homes and businesses located near the Site under RAP Modification #1 to the Consent Order. This investigation has determined that many homes and a commercial business are being affected by vapor intrusion and remedial actions are being taken to address this pathway.

The overall objective at any site is to prevent exposure and risks to human and environmental receptors. At this Site, constituents are present in soil and groundwater. Exposure to constituents in soil is not a pathway of concern because of the depth of the release (waste was poured into stacked perforated drums with much of the release likely towards the bottom of the drums [approximately 12 ft bgs]) and studies that indicate TCE in shallow soil are not a concern for dermal contact. In addition, ICs limit the potential for contact with soil at depths greater than 4 ft bgs. Groundwater is not used as a drinking water resource (**Section IV.3** and **Appendix B**); therefore, this pathway is not a concern. However, TCE in shallow groundwater has recently been determined to be a potential for soil gas vapors posing a risk of vapor intrusion into residential buildings. In light of the changing exposure pathways, a reevaluation of RAOs and response actions may be warranted.

Changes in chemical-specific target levels are provided in **Table 4.** This table does not reflect cleanup levels, which considers both toxicity and exposure potential but only reflects changes in toxicity. For example, the cleanup level established for the shallow groundwater was set at 270 µg/L, likely reflecting the toxicity value of a 10^{-6} risk at 2.7 µg/L, and an expected dilution and attenuation of 100 between the aquifer for which the cleanup level was established and any well

DRAFT FINAL

that could be used as a source of potable water. The new target level of a 10^{-6} risk at 0.6 µg/L suggests that this cleanup level should be lowered if potable use of groundwater were still a concern. However, an IC has been implemented and this cleanup level is no longer relevant. Cleanup levels for air have been developed for soil gas and are discussed in the RAP Modification #1 to the Consent Order.

Table 4: Changes in Chemical-Specific Target Levels

Contaminant	Media	Target Level (a)		Citation/Year
TCE	groundwater	Previous	10^{-6} risk at 2.7 µg/L	USEPA 1985
		New	10^{-6} risk at 0.6 µg/L	USEPA 2011
TCE	groundwater	Previous	30 µg/L	USEPA 2001
		New	18 µg/L	USEPA 2011
TCE	Air	Previous	10^{-6} risk at 0.6 µg/m^3	USEPA 2001
		New	10^{-6} risk at 0.025 µg/m^3	USEPA 2011
TCE	Air	Previous	40 µg/m^3	USEPA 2001
		New	2 µg/m^3	USEPA 2011

(a) Risk values are for continuous lifetime exposure at these concentrations; other values are concentrations considered unlikely to cause noncancer effects

VII.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Groundwater RAs currently being evaluated under this FYR focused on groundwater as a source of drinking water. Drinking water is not obtained from groundwater and the Site groundwater cleanup levels were not set at drinking water MCLs. In addition, through the imposition of ICs, future potential groundwater use as a source of drinking water is no longer a concern. Therefore, the remedy for the drinking water pathway remains protective of human health and the environment. However, the Consent Order RAOs and cleanup levels do not address the risk of soil gas vapors to indoor air pathway. As noted previously, the MPCA and GMI entered into an agreement (RAP Modification #1 to the Consent Order) to implement the RAs to address potential vapor intrusion risks associated with the VOCs at the Site. The RAs to be performed include: 1) sub-slab sampling and mitigation of potential vapor intrusion from VOCs in the soil and groundwater and 2) to conduct additional sampling and monitoring of soil, soil gas, and groundwater to collect data necessary to identify and evaluate RA alternatives as may be necessary to reduce VOC concentrations in soil, soil gas and groundwater to concentrations that adequately protect human health and the environment. RAs under the RAP Modification #1 will be evaluated under the next FYR.

VII.4 Technical Assessment Summary

In summary, the groundwater remedy is functioning as intended by the Consent Order and the drinking water pathway remains protective of human health and the environment. There were no changes in federal standards identified in this five-year period. Groundwater monitoring indicates that the idled pump-out and treatment systems continue to meet the RAOs and cleanup levels as specified in the Consent Order. However, an increase in TCE concentrations in recent sampling events indicates an increase in contaminant concentrations may be occurring.

Several monitoring and pump-out wells require maintenance. These wells are only inspected during the groundwater monitoring event (currently every five years). Annual well inspection and repair, as necessary, is recommended.

DRAFT FINAL

Recent concerns have been raised about the TCE concentrations in the shallow groundwater and the potential vapor intrusion pathway posed to buildings in vicinity of the Site. In accordance with RAP Modification #1 to the Consent Order, investigation activities are underway and soil sub-slab vapor mitigation systems are being installed into buildings in vicinity of the Site to address the vapor intrusion pathway.

DRAFT-FINAL

VIII. ISSUES/RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Table 5: Issues/Recommendations and Follow-up Actions

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
						Current	Future
GW	1. The site inspection identified several wells requiring maintenance and repair. See Appendix E for a complete list of wells and repairs needed.	Repair wells.	GMI	MPCA	11/1/2014	Yes	Yes
GW and Soil	2. Institutional Controls. The legal description alone is not adequate to identify the "Groundwater Impacted Area" and the "Soil Impacted Area".	Create a figure with GIS coordinates. Place figure in a readily available location for potential future needs (i.e., utility locators and construction).	GMI	MPCA	2/15/2015	No	Yes
GW	3. Most of the wells are in high traffic areas and LTM & O&M of the wells every five years is not adequate to ensure compliance with the MN well code.	Annual LTM and O&M are recommended.	GMI	MPCA	2/15/2015	Yes	No
GW	4. LTM of groundwater every five years is not adequate to monitor compliance with RAOs and cleanup levels.	Annual LTM is recommended.	GMI	MPCA	2/15/2015	No	Yes
GW, Air	5. Groundwater to indoor air pathway. Cleanup levels for vapor intrusion have not been established.	Develop groundwater RAOs and cleanup levels for vapor intrusion pathway.	GMI	MPCA	2/15/2015	Yes	Yes
GW	6. Groundwater monitoring network is inadequate	Monitoring wells will be installed as part of vapor intrusion investigation.	GMI	MPCA	2/15/2015	No	Yes
GW, Soil, Air	7. Toxicity values for TCE have decreased.	Complete comprehensive risk assessment for all pathways.	GMI	MPCA	6/15/2015	Yes	Yes

DRAFT-FINAL

In addition, the following are recommendations that were identified during the FYR that improve effectiveness of the remedy, provide technical improvement, improve management of O&M, and accelerate site close out, but do not affect current protectiveness:

- AMR should continue to present historical contaminant concentrations along with all VOCs detected. Statistical trend analysis should be performed to support stable/ receding contaminant concentrations/plume boundaries.
- MNA parameters should be collected from targeted wells for the evaluation of biodegradation potential and bioremediation to aid in evaluating all possible feasible RA for the vapor intrusion FS.
- The SECIA expressed concerns regarding the potential for soil contamination and requested removal of soils in the former adsorption pit area. Soil is unlikely to be an exposure concern, and soil remediation is unlikely to reduce source material, as documented in several reports (Barr 2001; Barr 2014b; Barr, 2014c). However, a report for public distribution summarizing these issues should be prepared in light of ongoing public concern.

DRAFT-FINAL

IX. PROTECTIVENESS STATEMENT(S)

Protectiveness Statement(s)		
Operable Unit: Groundwater (Drinking water Pathway)	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* Not Applicable
Protectiveness Statement: The groundwater remedy is protective of human health and the environment.		

Groundwater remedial actions evaluated under this FYR review focused on groundwater as a source of drinking water. The Consent Order cleanup levels have been met. However, the cleanup levels are not set at drinking water MCLs. Through the imposition of ICs, groundwater use is not a concern as a potable drinking water source; therefore, the remedy remains protective of human health and the environment.

Protectiveness Statement(s)		
Operable Unit: Soil (Direct Exposure pathway)	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* Not Applicable
Protectiveness Statement: No soil cleanup levels were specified in the Consent Order. No further action remedy for the soils is protective of human health and the environment.		

A restrictive covenant is in place that identifies land use restrictions as well as prohibiting access to soils below 4 ft bgs within the Soil Impacted Area.

Protectiveness Statement(s)		
Operable Unit: Air (Groundwater to Vapor Intrusion pathway)	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):* Next FYR
Protectiveness Statement: A new exposure pathway (vapor intrusion) has been identified. The sub-slab soil vapor mitigation systems currently protect human health and the environment because sub-slab vapors are being remediated prior to entering indoor air. However, in order for the remedy to be protective in the long-term, a RI and FS, including a risk evaluation must be completed, and RAs implemented as needed to ensure protectiveness. This exposure pathway will be evaluated at the next FYR.		

In order to address vapor intrusion concerns the Consent Order was amended on March 11, 2014, “RAP Modification #1” (MPCA, 2014). Investigation activities are underway and soil sub-slab vapor mitigation systems are being installed in residential and commercial buildings to address the vapor intrusion pathway. Implementation of RAP Modification #1 will be evaluated under the next FYR.

DRAFT FINAL

X. NEXT REVIEW

Hazardous substances or contaminants will remain at the Site and will not allow for UU/UE. The presence of hazardous substances will require additional FYRs of the Site. The next FYR is scheduled for completion five years from the signature date of this review.

DRAFT-FINAL

Appendix A

Figures

Figure 1 Monitoring Well Location Map

Figure 2 Well Pictures -South of Como

Figure 3 Well Pictures -North of Como

Figure 4 Site Inspection Observations

DRAFT-FINAL

Appendix B

Historical Data Tables and Figures

2012 Annual Monitoring Report (Barr, 2013a). Selected Figures and Tables

Draft Vapor Intrusion Pathway Investigation and Feasibility Study Work Plan (Barr, 2014a). Selected Figures and Tables

VI Building Mitigation Status as of July 23, 2014 (Web report printed on August 8, 2014)

VI Sub-slab Vapor Sampling Results Greater than 20 µg/m^3 as of July 23, 2014 (Web report printed on August 8, 2014

MDH SWCA (Barr, 2013b)

DRAFT FINAL

Appendix C

Community Notification and Response

MPCA webpage notification

Brenda Winkler E-Mail to SECIA with Notification for posting on SECIA webpage

Star Tribune Public Notice

Minnesota Daily Public Notice

SECIA Response Letter

MPCA Response Letter to SECIA

Judith Treise Comment Letter

DRAFT-FINAL

Appendix D

List of Documents Reviewed and Referenced

DRAFT-FINAL

Documents Reviewed

Barr, 2001. *Shallow Soil Investigation Around the Former Disposal Site, East Hennepin Avenue Site*. August 30, 2001.

Barr, 2010. *2009 Annual Monitoring Report*. March.

Barr, 2010. *Proposed Groundwater Pump Out System Shut Down and Monitoring Plan.* August 2.

Barr, 2011. *2010 Annual Monitoring Report.* February 28.

Barr, 2012*. Groundwater Pump-out System Shutdown Summary Report And 2011 Annual Report*. March.

Barr, 2013a. *2012 Annual Monitoring Report*, February.

Barr, 2013b. *2012 Receptor Well Survey*, February 11.

Barr, 2013c. *Monitoring Well Sealing Report*. August 8.

Barr, 2014a. *2013 Annual Monitoring Report.* February 28.

Barr, 2014b. Disposal Area Investigation Results, May 23.

Barr, 2014c. *Draft Vapor Intrusion Pathway Investigation and Feasibility Study Work Plan Sampling and Monitoring Work Plan*, June.

MPCA, 1984. *Response Order by Consent between General Mills, Inc. and the Minnesota Pollution Control Agency*. October 23.

MPCA, 1994. *Second Five-Year Review*. September.

MPCA. Various years. Site Status Reports published August 12, 2009; February 28, 2011; September 16, 2013; and October 31, 2013.

MPCA, 2001. *No Further Action Approval Letter for Shallow Soil Investigation Around the Former Disposal Site.* September 28.

MPCA, 1999. *Third Five-Year Review Report. General Mills/Henkel Corporation Superfund Site*. September.

MPCA, 2004a. *Declaration of Restrictions and Covenants and Affidavit Concerning Real Property Contaminated with Hazardous Substances.*

MPCA, 2004b. *Draft Fourth Five-Year Review Report. General Mills/Henkel Corporation Superfund Site*. September.

MPCA, 2014a. *Exhibit B RAP Modification #1 of the October 23, 1984 Response Order by Consent between General Mills, Inc. and the Minnesota Pollution Control Agency*. March 11.

MPCA, 2014b. Letter to Ms. Wendy Menken, Southeast Como Improvement Association. June 26.

USEPA, 2007. *Sites in Reuse Fact Sheet, General Mills/Henkel Corporation Superfund Site*. August.

USEPA, 2013. *USEPA Region 5 Fact Sheet for General Mills/Henkel Corporation.* December.

DRAFT-FINAL

Additional Documents Referenced

Barr Engineering Company (Barr), 1983. June 1983 Site Characterization Study and Remedial Action Plan, General Mills Solvent Disposal Site.

U.S. Environmental Protection Agency (USEPA), 1985. *Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites.* Prepared by Clement Associates for Office of Waste Program Enforcement. Washington, DC.

USEPA, 2001. *Trichloroethylene (Draft) Office of Research and Development, National Center for Environmental Assessment,* Washington Office, Washington DC, EPA/600/P-01/002A, 2001.

USEPA, 2004. *EPA WasteLAN Database*.

USEPA, 2011. *Integrated Risk Information System (IRIS) Trichloroethylene. (CASRN 79-01-6). http://www.epa.gov/iris/subst/0199.htm*, Washington DC

DRAFT-FINAL

Appendix E

Site Inspection Report

Site Inspection Report Form

Site Inspection Sign in Sheet

Site Inspection Well Inventory Table

DRAFT-FINAL

Appendix F

Interview Record

Interview Documentation Form
Mark Matasovsky Interview Record
Larry Deeney Interview Record
Ricardo McCurley Interview Record
Rita Messing Interview Record

DRAFT-FINAL